Experience build-up

4Subsea investigates used risers

- 28 860 m investigated in detail
- Intact and damaged
- PVDF, PA11, X-link PE pressure sheaths
- Norway, West Africa, Netherlands, UK
- Excellent cooperation with
  - Marintek
  - SINTEF
  - DNV
  - IFE
  - NorSea Base
  - Operators
  - Vendors
- 32 engineers full time on flexibles
- Over 400 years flex-riser experience
- Over 1500 offshore annulus tests & vent gas samples

It's so much more on flexibles to learn

JIPS
- Guidelines for Qualification of Polyamides & Revision of API 17TR2
- Safe and cost effective operation of flexible pipes
Flexible risers - Norwegian Continental Shelf

Enabling technology

What is CODAM database?

- Database managed by PSA
- Data as reported from operators
- Data from mid – 1970’s
- Flexible riser data structured from 1995
- Damages and incidents on structures and pipeline systems
- Focus on personnel risk

http://www.ptil.no/getfile.php/1.10.13Stigeroersskader.pdf

Potential for improvements
Flexible riser incidents reported to PSA

Flexible riser incidents 1995 - 2013 (oct)

Major incident
- High risk of injury
- High risk of pollution
(mainly based on operators' judgment)

Major incident: (typical)
Observation of damaged outer coating in riser guide tube at 12-14m below sea level. Vacuum testing confirmed leakage. Crack seen on video.
Most frequent riser incidents in Norway

Carcass incidents

- Collapse
- Pull-out – PVDF interaction
- Axial failure - hydrate blocking
- Sand Erosion
- Fatigue

Abrasion / Wear

- Bell Mouth / Guide Tube
- Interfacing Structures / Ancillaries
- Seabed At Riser Touch Down
- Internal Wear

Ageing

- Hydrolysis (External Sheath, Tape Layers, Pressure Sheath)
- High temperature (shielding/insulation)
Incident rate development

- **1995 - 1999**: 1.8%
- **2000 - 2004**: 1.6%
- **2005 - 2009**: 1.4%
- **2010 - 2013**: 1.2%

5 major incidents per riser year

**data to Oct 2013**
In total 80-100 risers replaced
- 30-50 risers replaced due to risk assessment
- 25-30% of the 324 risers in operation have been replaced or re-terminated

60 reported major incidents in CODAM (1995-2013)
- 49 risers reported to be replaced
- 11 risers repaired (later replaced?)

Other replacements (flexibles)
- Flowlines
- Topside jumpers
Operators checklist – Growing old gracefully

- Acknowledge the complexity and uncertainties related to flexible risers (design, fabrication, installation, operation)
- Map internal and external competence – fill the gaps!
- Facilitate communication, learning and knowledge management
- Focus on continuity (don’t redo the mistakes)
- Initiate and support research and development (much to gain by knowing more)
- Improve tools and methods
- Share experiences & best practices
- Develop and implement strategies

What is really needed to maintain a failure probability below $10^{-4}$?
PSA checklist – Growing old gracefully

- Ask the difficult questions
- Facilitate efficient & consistent reporting of all flexible pipe anomalies
- Follow up reports to CODAM
  - What was the end result?
  - Replacement or repair?
  - Additional info (retrospect)
- Facilitate experience sharing
- Provide rules and regulation courses to management personnel